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LESSONS ON POTATOES FOR ELEMENTARY RURAL SCHOOLS.

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INTRODUCTION.

Importance.—The potato is one of the most widely cultivated of the agricultural plants, and, next to Indian corn, it is the most important contribution of America to the food supply of the world. Probably no crop except rice is eaten by a greater number of people. In the more thickly populated regions of Northern Europe, the potato is now the most important of human foods, furnishing about 25 per cent of the food of the continental and English peoples. Only the Oriental peoples exist without it. Not only are the tubers used for food, but they have important industrial uses. The plant is allied botanically to several powerful narcotics, such as tobacco, henbane, and belladonna, and also the tomato, eggplant, and pepper.

As our American population increases, the potato will become more and more important in this country, there being no other crop which will give such a large yield of food suitable for man, under such varying conditions.

Educational value.—The importance of the potato crop as briefly indicated above and the fact that it can be grown successfully in every State in the Union, should give it a place in courses in general

agriculture and farm crops in nearly every school where such subjects are taught. At least one aim in the teaching of agriculture should be the training of farmers for the future, and as a result of such teaching the world should be better fed. The immediate aim in teaching this subject may be to aid in securing a production of better potatoes at a lower cost, but it may also be a medium for developing and applying many of the general principles of plant production. Applying these lessons to a home project will not only have greater agricultural value, but also will do much toward developing the student into a self-reliant husbandman.

Sources of information.—Nearly all the subject matter for class discussion and instructions for home project work will be found in bulletins available either free or at a small cost. Almost every State college of agriculture has published potato bulletins, and in many cases the extension service has issued circulars for school and club use. These may be obtained by addressing the dean of the agricultural college.

The Farmers' Bulletins of the United States Department of Agriculture cover most of the topics to be studied, and are suited to the use of the pupils. These bulletins may be obtained free as long as the supply lasts by applying to your Senator, Representative, or Delegate in Congress, or to the Division of Publications, United States Department of Agriculture, Washington, D. C. When this free supply is exhausted, a limited number are for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents each.[1] Seed houses frequently issue pamphlets on potatoes, and these may be obtained free. Farm journals from time to time publish articles on potatoes. These should be clipped and mounted. A good way to keep bulletins and clippings is to file them in pasteboard cases, grouping these references by subjects. Encourage pupils to bring reference material to school.[2]

Illustrative material.—As potatoes may be secured at any time of the year, there is no excuse for attempting to study the potato without having specimens at hand which represent common varieties grown in the district. The potato plant in the field should be studied during the different stages of development. Especially should the relation of the new tubers to the seed tuber and the root system of the plant be noted. If no plants are available, a diagram showing the plant as a whole will be useful. (The figure may be copied on the

[1] Classified lists of department publications on different phases of agriculture for teachers' use, together with other information for teachers of agriculture, may be obtained from the Division of Agricultural Instruction, States Relations Service, United States Department of Agriculture, Washington, D. C.

[2] Write to the Division of Agricultural Instruction, referred to above, for a circular on the essentials of a school library, describing a simple method of filing reference material.

board or made into a chart.) Charts showing the composition of the potato and its relative food values should also be made. Pictures clipped from bulletins, showing types of potatoes, may be mounted for class use. The teacher should keep in mind always the value of illustrative material in arousing interest and vitalizing the study of the subject. Continuous efforts should be made to visualize the lessons.

The survey.—One of the best means by which the teacher may become informed about the potato interests of the district is the potato survey. This survey may be made either by the teacher alone, or with the assistance of the pupils, the latter method being more easily carried out. The survey should include such questions as size of farm acreage in potatoes, soil, varieties of potatoes, yield per acre, value, bushels marketed and bushels used at home, storage methods, etc.

The general district survey as a means of obtaining agricultural information and as a basis for agricultural instruction may be set forth in the following outline:

THE DISTRICT SURVEY.

The aims—

To know the district.
To obtain a basis for teaching agriculture.
To interpret better State and national data.
To observe progress by successive surveys.
To provide vital correlation material.

The method—

Preparation of adequate lists of questions.
Collection of data, all farms, each pupil.
Tabulation of data by farms.
Summary of tabulations.
Mapping survey data.

Utilization as—

Basis of class instruction in agriculture.
Problems, reports, and other correlations.
Means of developing home projects.
Entering wedge for community service.

The home project.—It is agreed by teachers of agriculture that instruction in this subject should follow certain definite lines.

1. It should be seasonal; that is, a monthly or seasonal sequence should be followed out as far as possible in the presentation of these lessons.
2. It should be local in its interests and development.
3. It should meet the interests of the pupils.
4. It should be practical.

The home project affords the best means for meeting these conditions, especially the practical condition.

The term "home project" applied to instruction in agriculture includes each of the following requisites: (1) There must be a plan for work at home covering a season more or less extended. (2) It must be a part of the instruction in agriculture of the school. (3) There must be a problem more or less new to the pupil. (4) The parents and pupil should agree with the teacher on the plan. (5) Some competent person must supervise the work done at home. (6) Detailed records of time, method, cost, and income must be honestly kept. (7) A written report based upon the record must be submitted to the teacher. This report may be in the form of a booklet. The club project should be identical with the home project from the school point of view.

A potato project may take one of two different lines. It may be a production project where the chief aim is to increase the production per acre at the lowest cost; or it may be an improvement project where the aim is to improve, by careful selection, the quality and quantity of a variety of potatoes grown. The potatoes produced on the first project will be placed on the general market for consumption, while the surplus crop produced on the second will, after selection, be sold to dealers or producers for seed potatoes. The first type adapts itself the better to general conditions.

Correlations.—Some suggestions have been made in connection with each lesson, as to the use of this subject in vitalizing the other subjects in the curriculum. These correlation suggestions are not intended as a part of the lesson in which they appear, but should be used with recitations in other subjects. The teacher should seize every opportunity to link up the recitation with the life of the community and to give the instruction purpose and direction by connecting it with the problems of the home and farm.

LESSON I.

Subject.—Selection of seed potatoes in the field.

Problem.—To improve the potato crop year by year. To develop a strain which will produce well and with uniformity under local conditions.

Sources of information.—Farmers' Bulletin 533; Department Bulletins 176 and 195; bulletins and circulars from the State college of agriculture.

Illustrative material.—Four or five typical specimens of each variety of potatoes grown in the community. Typical plants of each variety. The entire yield of one good hill and of one poor hill, kept separate for contrast. Specimens of unmarketable potatoes showing defects. Pictures of ideal potatoes of the standard varieties should

be mounted and kept for class use. Obtain potato "balls," if possible.

Class exercise.—The first step in the selection of seed potatoes is the inspection of the field while the plants are yet green and vigorous. Why? Select and mark plants which are true to type, free from disease, stocky, and vigorous. The typical plants of the varieties grown in the district may be brought to class and their characteristics studied. Why is a vigorous top growth essential?

At the time of harvesting, select superior tubers from the best hills in the areas previously worked. Choose productive hills which have a good number of fairly large tubers and very few culls. If the grower is interested in selecting and breeding a superior strain, it may be desirable to keep separate the product of several especially good hills. All tubers selected should be normal in size, shape, and color, and free from scab and other signs of disease. Somewhat immature tubers make better seed.

What varieties, early and late, are most common in this district? Which have only a local reputation? Which market readily? Why is it not as well to plant the seed from the "seed ball" as to use the tubers? Why not make the selection from the bin in the spring?

Practical exercises.—Have each pupil practice identifying in the classroom the varieties of potatoes to be found in the district. If any have peculiar local names, try to classify them. (See Department Bulletin No. 176.) Have each variety examined to observe: (1) Plants—size, branching, stockiness, color, and freedom from disease. (2) Leaves—size, color, and peculiarities. (3) Color of the flowers. (4) In the spring the shape and color of the sprouts are important. (5) Tubers—shape, normal size, color, and markings of the skin, number and depth of eyes, color and condition of flesh.

Arrange for a field trip during which the class shall examine some good potato fields and select the sections of the field from which the seed should be taken, giving reasons for the choice. If the owner is willing, have a few hills dug and the plant and tubers discussed. Show that the tuber is a stem and not a root. Note any peculiarity of any variety as adapted to certain soil or climatic conditions. Have pupils apply this lesson in their own home project.

Correlations.—Have the pupils collect and compile the district survey of the potato crop as suggested by the form given below. This will provide ample correlations in arithmetic, language, and spelling. Dictate a list of questions to the class and divide the farms of the district among them so that all may be reported on soon. Include also, questions as to methods, prices, shipping rates, weights, capacity and kinds of packages, disposal of culls, and other data. Some of the information can not be given before harvesting.

DISTRICT SURVEY OF THE POTATO CROP.

Name of district_____ Date_____

Farmers.	Tillable acres.	Acres in potatoes.	Per cent of land in potatoes.	Total crop.		Per acre.		Bushels sold.	Rate per bushel.	Income.		Bushels for home.
				Early.	Late.	Early.	Late.			Gross.	Net.	
Mr. A												
Mr. B												
Etc												
Total												

Potato crop summary_____ Date_____

Varieties.	Acres planted.	Yield.		Acre yield.	Bushels sold in field.	Price per bushel.	Total income.	Bushels stored for—			
		Good.	Culls.					Home use.	Home seed.	Market.	Seed for sale.
Early:											
Early rose											
Cobbler											
Etc											
Etc											
Late:											
Green Mountain											
Rural											
Etc											
Etc											
Total											

LESSON II.

Subject.—Harvesting and grading potatoes.

Problem.—To study the farm practice in harvesting and grading potatoes with a view to finding the most efficient methods of handling the potato crop.

Sources of information.—Farmers' Bulletin 753; Document, Markets, 7; circulars and bulletins from State college of agriculture; articles in the farm papers.

Class exercise.—The application of this subject to the seasonal practice of the district and to the projects of the pupils will call for modifications to suit each case. Late potatoes are harvested in the Northern tier of States from the latter part of August to the middle of October. In the Northern States the main crop is planted during the summer and the harvest begins after the middle of October. In all cases this lesson should be taken at such a time that the class may observe or participate in the harvesting and grading soon after the school work in the same subject. The following items of farm practice in the handling of potatoes should be noted:

1. The time to dig will vary with market conditions and other factors. They should be dug as soon as vines die, earlier if mature.

2. Small areas may be dug by hand, with hooks or potato forks. All large acreages are now dug by machinery.

3. Make field trials on the given soil before adopting any digger. Unless the field has been kept very clean it will pay to mow, rake, and burn all weeds before digging. Weeds and tops tend to clog digger.

4. After digging, let tubers lie on ground long enough for dirt to dry out, also to toughen the skin against bruising.

5. Careful handling pays at every stage. Bruised or cut potatoes decay readily and every tuber lost reduces the profits. Hardening process must not be prolonged to the extent of sunburn (especial care with some varieties).

6. Sorter may be used in field if weather permits. Potatoes sold in field weigh more than stored potatoes.

7. The careful sorting and grading of potatoes is quite as important as the grading of fruits.

Practical exercises.—Discuss the methods of harvesting potatoes in this district and elsewhere. Arrange for the class to take a field trip to observe the methods of harvesting and sorting potatoes at one of the most approved and successful potato farms in the district. Discuss methods of sorting. Need of keeping varieties separate Sorting by sizes. Keeping out diseased potatoes. Find out what the farmers are doing with culls. If potato-digging machinery is used, make a study of the different machines with a view of finding out which one is best adapted to the soils of this section. Visit a dealer and inspect the machines he carries in stock. What is the common method of sorting potatoes? What sorting machines are used? What type seems to be the best adapted for its work? Note the methods of handling the crop, such as packing and hauling.

Correlations.—Arithmetic: Use local yields and prices and make problems suited to advancement of the class. Obtain State records of potato crop and the market price for further problems.

Language: Utilize for written or oral exercises such topics as: "A trip to observe potato harvesting," "How to sort potatoes," "Potato-harvesting machinery."

LESSON III.

Subject.—Marketing potatoes.

Problem.—To discover the best farm methods of marketing potatoes in order that they will bring the highest market price and reach consumer in first-class condition.

Sources of information.—Farmers' Bulletins 365 and 753; Office of Secretary, Circular 48; Document, Markets, 17; publications from State college of agriculture; articles in farm papers.

Illustrative material.—Procure samples of typical marketable potatoes of both grade No. 1 and grade No. 2, using varieties common in district, specimens of imperfect and diseased potatoes, pictures and drawings of various containers for marketing potatoes, samples of crates and baskets for marketing small lots, a map of the State and the United States showing railroad routes to the chief markets for the district, pictures or diagrams showing methods of loading in part or in full carload lots. Procure samples of potatoes for sale on the market and compare with the samples of typical grades.

Class exercise.—Discuss the following topics with the class:

1. The grading of potatoes for market, stressing quality as well as uniformity.
2. Preparing for shipping—the package, crate, barrel, box, sack; advantages and disadvantages of each. What package is commonly used in this district?
3. The market for the crop, local and shipping.
4. Prevailing prices.
5. Cooperative shipping organizations.
6. Are the potatoes shipped in small lots or by the carload?
7. What is the general practice regarding the selling and shipping—potatoes sold in the field, f. o. b. the car, shipped to a commission merchant; open shipment, shipped with bill of lading attached, or shipped billed to the shipper?

Practical exercises.—Plan a field trip to a potato farm or a potato storage house to observe the methods practiced in preparing potatoes for market and shipping. If potatoes grown in the district are sold in local markets, visit these markets to observe the way these potatoes are sorted and handled. Note prices for same and compare with prices received in other markets and when shipped. If there is a community marketing association, the class should make inquiries as to their methods of handling and shipping the crop, the number of bushels handled, markets supplied, and net price to shippers. Discover what use is made of culls. A class discussion as to the proper way to handle culls will be profitable.

Correlations.—On a map of the United States locate the chief markets supplied. What railroads carry the potatoes? Locate the potato-growing sections of the State and of the United States. These exercises will afford good practice in geography.

Arithmetic: From the information gathered in the practical exercises and class study make problems adapted to this lesson and grade of the pupils.

Language: Written or oral exercises on "Grading potatoes," "Preparing for shipment," and "Potatoes on the local market," will give abundant practice in language.

LESSON IV.

Subject.—Winter storage.

Problem.—The preservation of the potato crop during the winter so that it may be available either for market or home use.

Sources of information.—Farmers' Bulletins 847 and 879; bulletins and circulars from State college of agriculture; articles in farm papers.

Illustrative material.—Clip from farm journals pictures showing various types of storage and mount these for class use. From bulletins and farm papers enlarge drawings of pit storage; show a cross and a vertical section. Do the same for a storage house, showing floor plans and vertical sections, giving arrangement of bins and shelves. If possible, secure photographs of community-storage houses and mount them for classroom use. Construct charts showing the advantages of storing products and the essential factors of storage. Small models of wooden storage houses may be constructed by the members of the class.

Class exercise.—The following topics should be discussed with the class:

1. Importance of storage.

2. Object of storage—economy, holding a more or less perishable product in a salable condition as long as possible, providing for a uniform market supply.

3. Essential factors in storage—(*a*) product well matured, (*b*) careful handling, avoid bruising, (*c*) uniform temperature after storing, (*d*) the moisture content of the air, (*e*) exclusion of light.

4. Types of potato storage—(*a*) in basement of house; storage rooms constructed in cellars, plans, ventilation, containers, (*b*) outside storage caves or cellars; advantages, location, construction; storage construction in mild regions, storage construction in regions of severe freezes, concrete storage cellars, advantages, site, construction, (*c*) storage in banks or pits; location, how constructed, ventilation, advantages, disadvantages, (*d*) community storage house; plans, construction, how conducted, advantages.

Practical exercises.—Make a study of the farm practice generally observed in storing potatoes. What method of storage is most common? What other method might be more effective? What is the purpose of storing potatoes, for the home or for the market? Is there community potato storage in the district? How is it constructed? How managed? What quantity of potatoes is commonly stored there? What is the cost of storage? How well is it patronized? Does it seem to be successful? If possible, visit with the class a farm where potatoes are being stored and note the methods used in preparation for storing and the methods used in storing. Note the construction of any storage houses that may be visited in the district.

Correlations.—A report on the general practice of the district in storing potatoes will provide good exercises in oral or written language. A detailed account of the making, filling, and covering of a storage pit will also provide good language material. Another interesting language study will be a comparison of the storage methods of the warmer regions with those of the colder regions.

Arithmetic: Problems involving the amount and value of potatoes stored will be suggested by this lesson. The amounts from each farm and totals for the district. The values of the potatoes on the fall market compared with the value on the spring market will provide further material.

Geography: Locate the sources of potatoes shipped into the district. How near does the district store its own supply of potatoes? If the stored potatoes are sold, trace their route to the consumer.

LESSON V.

Subject.—Potato judging.

Problem.—To be able to identify the leading varieties of potatoes and to recognize the chief characteristics of each variety.

Sources of information.—Farmers' Bulletin 533; Department Bulletin 176; bulletins of State college of agriculture; extension leaflets; circulars; score cards from State college of agriculture.

Illustrative material.—From seed catalogues and farm papers, clip and mount pictures of varieties of potatoes. From the farmers or from dealers, secure at least three typical specimens of the different varieties of potatoes raised in the district or on sale in the market. These should be carefully taken care of for class study.

Class exercise.—This lesson is essentially a lesson of practice in studying the varieties of potatoes. The following leading factors should be noted:

1. Trueness to type, uniform in size, shape, color, etc., according to variety of class; no mixture.

2. Uniformity: General uniformity in shape, length, and circumference.

3. Shape of tuber: Round, oval, or long, according to class or variety.

4. Color: Conforming to class or variety and free from green.

5. Size: Medium—average weight for early varieties 8 ounces, or late varieties 12 ounces.

6. Eyes: The eyes of the potato should be medium deep, well defined, and not too numerous. Deep eyes cause waste in paring. Shallow eyes are low in vitality, and too many eyes denote poor stock.

7. Skin: Smooth without cracks or blemishes. The skin may be whitish, brown, reddish, yellowish brown, blue, or black, depending

upon variety. It may be thick or thin, tough or brittle. A thick, fairly tough skin is preferred.

8. Flesh: When cut, firm, clear in color, free from hollow center, dark rings, discoloration, woodiness.

9. Freedom from blemishes: No scab spots or skin ruptures from any other diseases, no cuts, bruises, scratches, or other defects.

Practical exercises.—Students should practice on identifying the different varieties of potatoes until they can be recognized at sight. The chief characteristics noted above should be studied and students taught to observe varieties from type. Use score card suggested below or ask the State agricultural college for enough to supply the class. Require the students to mark the points on the card. Compare with a typical potato (either a real potato or a good picture of one) to note any difference. Hold judging contests in which the students will be required to judge and score the different varieties. Ask for the help of the county agent in these contests. Make this work of a practical nature, and drill until the pupils are able to recognize readily the different kinds of potatoes and to score them fairly accurately. The following form of score card may be used:

POTATO SCORE CARD.

Variety—Name_____

Scale of points.	Standard.	Student's score.	Corrected.
Trueness to type	20		
Uniformity	15		
Shape	20		
Color	5		
Size	10		
Eyes	5		
Skin	5		
Flesh	5		
Freedom from blemishes	15		
Total	100		

Scored by_____ Date_____

NOTE.—Give directions for using the above card.

Correlations.—Language: Oral or written reports on the kinds of potatoes grown in the district or in the State; how to judge potatoes; a history of the chief classes of potatoes will all provide abundant language work.

History: Write a history of the potato, an account of its introduction into Europe, the story of Luther Burbank and the Burbank potato.

Arithmetic: If potatoes scoring 100 points are worth $2.50 per bushel, what would be the value per bushel of the potatoes scored,

basing their worth upon the points scored? Rating in this manner, what would be the loss at current market prices, on a 10-acre crop of each variety scored if the yield was 175 bushels per acre?

LESSON VI.

Subject.—The potato tuber (and plant) structure.

Problem.—To understand methods of potato requirements for growth.

Sources of information.—Farmers' Bulletin 533; Department Bulletin 176; bulletins from State college of agriculture.

Illustrative material.—Potato tuber specimens. The entire plant showing roots and clinging tubers. Obtain, if possible, entire plant of the tomato, tobacco, and jimson weed and other relatives of the potato. If plants are not obtainable, a diagram showing the potato plant as a whole will be found useful. Pictures of the related plants will be found in publications and may be used also. Charts may be used to show structure of the tuber and to illustrate types in connection with such specimens as may be obtained.

Class exercise.—The potato plant. Discuss with the class the following topics:

1. The potato-plant family, cultivated members, nature of some of the wild relatives.

2. What resemblances do you note between the tomato and the potato? Compare the fruit of the potato with the fruit of the tomato.

3. Make a study of the stem, branching flowers, and seed balls.

4. Note differences in the plants and flowers of different kinds of potatoes.

5. Why do not all varieties of potatoes produce fruit?

6. The tuber: Note arrangement of eyes upon the tuber and trace their relationship to buds. Distinguish clearly between seed potatoes and the real seed produced in the fruit.

7. Study the root system of the plant and note the relation of the new tubers to the seed tuber.

8. Cut the potato tuber into sections and note its different parts.

9. What resemblance can you find between the structure of a tuber and the structure of the green stem of a plant?

Practical exercises.—Students should be required as far as possible to study the complete plant of the potato and related plants. The characteristics of the plant should be noted and comparisons made between the different varieties of potatoes. Contrasting studies of the potato and related plants should be made. It should be clearly shown that the tuber is an underground stem and not a root. Cross and longitudinal sections of the tuber should be made and the

various parts of its structure noted. What distinguishes the potato from the other members of the nightshade family? A study of the characteristics of the various types of potatoes should be made with a view of aiding the student to identify the different groups.

Correlations.—Drawings of a tuber, showing parts, and of sections showing structure should be made. In studying the entire plant the student may sketch the plant or make a copy from a chart.

Language: Look up the nightshade family of plants in a good reference book, and bring to class a written report on same. Make a written or oral report on the differences between the potato and tomato or other members of that family. Write an account of the usefulness of the nightshade family.

LESSON VII.

Subject.—Place of potatoes in the rotation.

Problem.—To study the place of potatoes in a rotation in order that the greatest yields may be made and soil fertility maintained.

Sources of information.—Farmers' Bulletin 365; a good reference text; bulletins from the State college of agriculture.

Illustrative material.—Comparative charts showing yields of potatoes grown in a rotation and those grown continuously on the same field; field diagram showing suggested 3-year, 4-year, and 5-year rotations; diagram of crop rotation with potatoes actually being carried out in the district. All these will make helpful illustrative material.

Class exercise.—Discuss with the class the following topics showing the advantage of growing potatoes in a rotation with other crops:

1. Plant diseases often become rapidly worse in the continuous cropping system, which has often been the case with potatoes. The class may be shown how modern scientific methods of care of seed selection, disinfection, spraying, and other details of culture somewhat reduce this danger.

2. In the business management of the farm rotation reduces the danger of excessive losses in seasons of low prices or of poor yields and arranges the work of the farmer through the season to better advantage.

3. Weeds are more easily controlled under a system of rotation. The high value of the potato crop pays for thorough tillage and care which cleans the soil of weeds for the rest of the rotation.

4. Insect pests are kept down more easily under rotation.

5. The high cash value of the potato justifies considerable expenditure for fertilizers, and justifies the use of more of the time of the rotation in producing organic matter to be returned later to the

soil. The thorough culture, late digging, and winter exposure of soil, especially in the Northern States, rapidly use up the soil organic matter. The cheapest and easiest way of replacement is by rotation with grass, clover, and other hay crops which have a money value as food for animals, and also leave large amounts of organic matter in the soil from their roots and stubble, as well as that in the manure from the hay feed.

6. Different plants draw on the plant food in the soil in varying proportions, consequently a rotation of crops utilizes the plant food to better advantage than a single crop grown continuously.

7. Though the potato sends its roots deeper than some other crops, others, like clover and alfalfa, root much deeper. These bring up fertility from the subsoil, and the roots of the potatoes following are able to grow lower, even in hard clay soils.[1]

8. The theory has been advanced that plants in their growth throw off in the soil toxic substances which, by accumulation, become injurious to succeeding crops of the same plant, but not to others. Rotation avoids this possible danger.

9. The physical condition of the soil for succeeding crops is improved by the thorough culture given the potato. Examples of this are the use of wheat following potatoes without plowing in the fall, and oats without plowing in the spring.

The net return of the rotation as a whole must be the deciding factor in the choice of crops. The potato gives such large cash returns to the acre and responds so well to the use of fertilizers, that usually it is the most important crop of the rotation in which it is grown. Wherever this is true, the choice of other crops to go with it is largely governed by the effect on the soil for the production of the potato.

Some suggested rotations are:

1. Potatoes—oats—grass and clover—grass and clover—potatoes.
2. Potatoes—wheat—clover—potatoes.
3. Clover or alfalfa—a small grain—potatoes.
4. Potatoes—wheat—clover—potatoes.
5. Potatoes—small grain—clover.
6. Potatoes—corn—cowpeas.
7. Winter rye—clover—potatoes.
8. Small grain two years—clover—potatoes.

Practical exercises.—Have the class make a study of the district farm practice in potato growing. What are the common rotations? What examples can be found of the continuous cropping? What differences in yields may be noticed? Does the acreage in potatoes on the farms of the district justify any plan of rotation of crops? (See potato survey. If possible, visit one or more farms where rota-

[1] Colorado Sta. Bul. 216.

tions in connection with potato crops are being carried out and note general conditions of fields, crops, and tillage.)

Correlations.—Correlations in language will be suggested in the matter of written or oral reports on field trips and observations made in the study of the farm practice of the district in rotations.

Drawing: The construction of the charts suggested under illustrative material will afford practice in drawing.

Arithmetic: Problems on yields of potato crops on both rotation plan and the continuous cropping plan will be suggested in the study of this lesson.

LESSON VIII.

Subject.—Soils—kind, preparation, fertilizers, etc.

Problem.—To study kinds of soils suitable for potato growing, their preparation and fertilizing.

Sources of information.—Farmers' Bulletins 365, 386, and 407; bulletins from State college of agriculture.

Illustrative material.—Collect soil samples from the potato farms of the district; bottle and use in class for comparison. Collect in a like manner the various commercial fertilizers used for potatoes. Clip and mount pictures from farm papers, circulars, etc., showing soil preparation such as plowing, harrowing, applying fertilizers, etc.

Class exercise.—Characteristics of potato soil: Rich, well cultivated, one that will conserve moisture and retain soluble fertilizer, a light sandy loam to be preferred to a heavy retentive soil. While excellent crops are frequently grown on heavy clay soils, the lighter soils will usually produce smoother, more even potatoes with bright skin and eyes of medium depth, and usually mature the crop at an earlier date.

1. Prepartion of the soil: Object of soil preparation—to provide for a rather weak root system, correct faults of local soil and climate, reduce the tillage after planting as much as possible.

2. Time of plowing—winter or fall plowing more desirable, especially where the soil does not run together and the slope is not steep enough to cause washing. This lessens the spring work and sometimes makes earlier planting possible.

3. Depth of plowing varies with the soil, usually from 8 to 12 inches unless subsoil is too near the surface.

4. Fertilizers: Object of fertilizing—potatoes require a complete fertilizer on most soils. Commercial fertilizers. Rotation. Green manuring. What objections to use of barnyard manure? When should lime be used? Methods of applying fertilizers to the potato crop.

Practical exercises.—Make a study of the types of soil in which potatoes are grown in the district. Which is most common? How

do the yields on the various types compare? Compare the quality of the potato crop raised on the different soils. How deep do the farmers of the district plow their potato soil? What is the common practice as to the time for plowing, fall or spring? What advantages can be found in either time of plowing? If the potato crop is one in a rotation, what is the usual practice in the district regarding fertilizers? If without a rotation, what is the practice? Note the farms that use green manure, that use stable manure, those that use commercial fertilizers, or a combination of fertilizers; and compare yields, both as to amount and to quality. Study the methods used by a successful potato grower of the district.

Correlations.—Correlations in language will be suggested by the various reports in practical exercises. Fertilizer costs, cost of plowing and otherwise preparing the land, will provide suitable correlations in arithmetic. In geography, a study of the commercial fertilizer as to source, manufacture, and shipping routes, will prove interesting and instructive.

LESSON IX.

Subject.—Planting potatoes including the treatment of seed.

Problem.—How should potatoes be prepared for planting, treated for disease, and when is the best time for planting?

Sources of information.—Farmers' Bulletins 386, 407, and 544; bulletins from State college of agriculture; textbooks in agriculture.

Illustrative material.—Specimens of diseased potatoes should be brought to the school and a comparison made between them and potatoes free from disease. Potatoes properly cut should also form a part of the illustrative material. The formula for treating potatoes should be placed on a chart in the room. Secure a small amount of formalin, and with the assistance of the class prepare some of the solution of the right strength for treating potatoes.

Class exercise.—Discuss the following topics:

1. Preparation for planting.—Treating the seed, purpose, diseases that may be treated, solutions used, method, results, cutting the seed, and principles involved which follow:

(*a*) Seed pieces should be blocky in shape to make surfaces as small as possible.

(*b*) The probability in most cases that the seed and eyes are more vigorous makes it better to cut each tuber in such shaped pieces that it will give the largest number having eyes from the seed end.

(*c*) To make sure of one good eye on every seed piece, it is well to have two wherever possible.

(*d*) The average weight of the seed must be adjusted to the needs of the crop for the soil planted—method of cutting, cutting racks, value of whole seed compared with cut seed.

2. A practice more or less common in Europe and one which is used to some extent in the United States is that of greening seed. Essentially it consists in keeping the seed during winter and spring in shallow trays racked up in buildings so constructed that each tuber is in the light. The sprouts at the seed ends start and grow short, green, and stubby. When planted, these potatoes start quickly and grow rapidly. The cost of the equipment and of the labor required to place the seed in the racks and again to place the seed in the ground with the sprouts up would be heavy in the United States. Unless seed which has been sprouted in this way for some time is planted with the sprouts up, there is trouble in loss of stand. However, a modification of the plan may be used for American conditions of cost and labor such that green sprouts grown in the light for a short time will not be broken off in a potato planter, and will give no trouble about coming up. Therefore the seed may be kept on the barn floor in the sun for two weeks or less and save the strength of the sprouts which would be lost by growth in the cellar.

For potato growers who desire to get their potatoes on an early market, a saving from one week to ten days may be made by this process.

3. Planting the crop—Time of planting depends upon the local soil, climate, and the market for which the crop is grown. Discuss advantages of early and late plantings; compare methods of ridging and level culture. Upon what does the value of each method depend? Methods of planting hill and drill—advantages and disadvantages of each; depth of planting and distance apart of plants and rows; planting tools; where would machinery for planting be economical? Discuss hand planting; depth of planting.

Practical exercises.—As a preliminary to the treatment of seed potatoes for diseases, some instruction on how to identify such diseases should be given. The student should be given an opportunity to sort potatoes, picking out those that show signs of disease. Practice should be given in preparing the formalin solution and in actually treating the seed potatoes. One pint of formalin (a 40 per cent solution of formaldehyde) diluted in 30 gallons of water is sufficient to treat 20 bushels of seed. Soak the potatoes about two hours. Actual practice in the cutting of potatoes should be given. If possible, take the class to a farm where potatoes are being planted, and with the consent of the owner, have them take part in the various planting processes from cutting the potatoes, to dropping and covering. Those students who have a potato project may obtain the practice work on their own plats, or may assist their fathers in planting. In such cases a report of the process should be made to the class. Where the potato scab is found, observations should be taken,

comparisons made between the yield with treated seed and with nontreated seed, both as to quality and quantity.

Correlations.—Problems in arithmetic growing out of comparisons between yields of treated and nontreated seed, together with cost of production in either case, including cost of treating compared with increase in yield, will be found valuable.

Written reports on treating seed potatoes and of the planting processes will afford language material.

LESSON X.

Subject.—Cultivation—first. Later.

Problem.—To study the correct methods of potato crop cultivation in order that the maximum yield may be secured.

Sources of information.—Farmers' Bulletin 365 (5 cents), 386 (5 cents), 407, and bulletins from State agricultural college.

Illustrative material.—Clip from farm papers pictures showing cultivation of potatoes; pictures of various kinds of cultivators and tools for tillage. If possible, have some of these cultivators brought to school where they may be examined. Visit a farm and see these tools in actual operation.

Class exercise.—The following principles in potato cultivation are noted and should be discussed as a basis for the practice work in growing potatoes:

Early cultivation:

1. Is it safe to assert that the major part of the cultivation of the potato crop should be done before planting.

2. Poor cultivation often the cause of poor yields.

3. Before potatoes are up, the field should be blind cultivated with a spike-toothed harrow or weeder.

4. Weeds should be destroyed and ground mulched.

5. After potatoes are up, deeper cultivation should be practiced, depth up to 8 to 10 inches, depending upon soil and locality.

6. Usually level cultivation brings better results than hilling. (Under what circumstances is ridging the better practice?)

7. The frequency of early cultivation depends largely upon the character of the season.

8. The things to be accomplished: Keeping down the weeds and conserving moisture.

Later cultivation:

1. Depth, shallow; form, level; ridge slightly after tubers are formed to prevent sunburn.

2. How long kept up should be determined largely by the season and condition of crop. As long as plants are green they are producing tubers.

3. Types of cultivators: Weeder, disk cultivator, corn cultivator, two-horse cultivator for large fields.

Cautions:

1. Careless tillage may work great injury upon the crop, as potato plants are more tender than weeds.

2. In using weeder or tooth harrow great care must be taken to prevent the teeth from injuring the sprouts.

3. In later growth the roots are in danger from too deep or too close cultivation. The greatest development of the roots in the plowed area is from 5 to 10 inches below the surface.

4. The danger of injury to the potato plant is greatest at blossoming time, when the exhausting effects of blossoming and forming tubers at the same time are very heavy.

Practical exercises.—This lesson should essentially be a guide to proper practice in potato cultivation. Many of the pupils will have potatoes as a home project, others will assist in the home work on the farm where potatoes are raised. The principles laid down in this lesson should be put into careful practice in either case.

A field trip to a potato farm would be valuable to the class. If the projects are under the supervision of the school, the teacher should try to visit each home as soon as possible to observe the progress of the projects. If the teacher is working in cooperation with the county or State club leader, it will be especially helpful to make these visits at the same time the official representative makes his visits to the work. In all cases this cooperation should strengthen the school work if it is well carried out.

Correlations.—The written reports, summaries, and costs of production as completed in the project work will furnish ample correlations in language and arithmetic. In case there is no project, the same reports on the work of the pupil on the home farm will furnish the same material.

LESSON XI.

Subject.—Potato-crop pests—Insects and diseases, how to combat them.

Problem.—To learn to identify the chief potato insect pests and diseases and to discover proper methods of control.

Sources of information.—Farmers' Bulletins 544, 557, and 868; bulletins from State college of agriculture.

Illustrative material.—Spraying charts. Illustrations of spraying apparatus. Samples of sprayers may often be borrowed from a farmer in the district or loaned by the local dealer. Samples of fungicides and insecticides. Illustrations or exhibits of the pests to be controlled. Samples of potato plants affected with the common fungus diseases may be brought to class for a study of the characteristics of the disease.

Class exercise.—The following topics are suggested as the basis of the class-room discussion:

A. Fundamentals of control:

Thorough spraying, clean cultivation, destruction of rubbish, and rotation of crops. Since there is a similarity in general methods, control of insects and diseases may be considered together.

B. Insect pests:

Insects damaging the potato crop may be classified as follows: (1) Insects chewing the leaves; (2) insects sucking the leaves and tips; (3) stalk borers; (4) insects affecting the tubers.

The following may be considered the chief insect pests of the potato plant:

Colorado potato beetle—Eats the leaves; controlled by spraying with arsenate of lead or Paris green.

Blister beetles—Leaf eaters; controlled same as Colorado beetles.

Potato flea-beetles—Leaf eaters; harder to control; spray with Bordeaux and arsenate of lead as probably the best means of control.

Leafhopper and plant-lice—Suck the leaves and tips; control by spray of nicotine sulphate or kerosene emulsion.

Potato-stalk weevil—Bores into the stalk; burn all infested vines; clear ground and burn all old stalks; destroy all related weeds; rotate crops.

White grubs (the larvæ of May beetles or June bugs)—Commonly known as "grubworms;" control by fall plowing and turn soil again in spring; rotation of crops.

C. Potato diseases:

1. Common diseases affecting the skin of the tuber:
   - (*a*) Common scab—Control; treat seed, rotation of crops.
   - (*b*) Russet scab—Control; treat seed, change of soil, deep preparation and cultivation.
   - (*c*) Powdery scab—Control; treat seed.
   - (*d*) Late blight dry-rot—Control; Bordeaux for blight, careful sorting and storing of the tubers.
   - (*e*) Powdery dry-rot—Control; care in handling; sorting out of injured potatoes.
   - (*f*) Eelworm—Control; careful selection.
2. Diseases of stem and leaves:
   - (*a*) Blackleg—Control; selected seed, formaldehyde treatment.
   - (*b*) Fusarium wilt—Control; rotation and sanitation.
   - (*c*) Bacterial wilt—Control; clean seed, sanitation.
   - (*d*) Early blight—Control; Bordeaux spray.
   - (*e*) Late blight—Control; Bordeaux spray.
   - (*f*) Rhizoctoniose—Control; clean seed, formaldehyde treatments, rotation.
   - (*g*) Tipburn—Control; in a measure, by Bordeaux, thorough cultivation.

D. Summary of control measures:

1. Results of seed selection; results in eliminating wilts, blackleg, eelworm, and other diseases which show on vines.
2. Results of seed treatment and rotation; reduce injury from Rhizoctoniose, scab, and blackleg, give clean seed.
3. Results of spraying; prevents early and late blight, prevents the blight rot, reduces injury from tipburn, repels flea beetles, kills most of the other insect pests, stimulates the vines to longer growth, gives increased yields.

E. Notes on spraying:

1. It pays to spray. It is economical to use a combination spray, a poison and Bordeaux.
2. Application should be timely and thorough; all the vines need to be well covered.
3. Do not wait until the plant disease begins to show among the vines. Anticipate its coming and spray before it arrives.
4. Do the work in season. Do not wait until it is too late. Once the blight gets a start in the potato field, it is very difficult to control.
5. Do not buy too cheap a machine. Get a good one and save time, trouble, and expense.
6. Be sure that the material is properly prepared.

Practical exercises.—This lesson should be made essentially a lesson of practice. Whenever practical, specimens of the insect pests should be brought to the class and identified. The treatment for such should be understood. In a like manner specimens of diseased potato plants and tubers should be studied. Pupils should be taught at least to identify the blights and scabs. The methods for control of each should be discussed carefully. Since the Bordeaux mixture for diseases and the arsenic poison for insects are the common sprays, the advantage of the combination spray should be shown. Actual practice work in preparation of these sprays and in their application should be given. Visit a potato farm and observe the spraying methods. If deemed practical, allow the class to assist in the spraying. By using borrowed sprayers and water in place of spray solution, actual practice may be given the class in the handling of sprayers and in the method of applying the spray. Instruct the class to be on the outlook for signs of potato diseases and insect pests, and have same reported to the class and a study made at once. To summarize: Give plenty of practice in identification of insect pests and diseases, practice in preparation and use of sprays, and drill in the general control methods outside of spraying. If any one of the students has a potato project, he can apply the principles of this lesson to his own crop.

Correlations.—Spraying costs compared with additional yield and losses incurred where no spraying is done; comparative cost of spraying with other costs of production will give practice work in arithmetic. The formulas for spray mixtures will also give additional practice.

Reports on observations and practice work will give language material and the preparation of spray charts and formulas will afford work in drawing.

LESSON XII.

Subject.—Uses of the potato—The potato as a food.

Problem.—To study composition, food value, and uses of the potato.

Sources of information.—Farmers' Bulletin 295; Office of the Secretary Circular 106; Department Bulletin 468; bulletins from State college of agriculture.

Illustrative material.—Construct a chart showing the composition of the potato; another showing the food value of the potato when compared with other foods. Samples of potato starch, alcohol, potato flour, and other products obtained from the potato.

Class exercises.—The following topics are suggested for attention in this lesson:

1. Composition of the potato—Water, starch, protein, crude fiber, fat, ash. Use iodin test for starch; use nitric acid and ammonia test for protein. Put a bit of potato on a piece of paper and put it into the oven or on top of a stove which is not hot enough to burn the paper. After heating hold paper up to light and see whether you can note any evidence of fat.

2. Uses of the potato—Potato starch, industrial alcohol, potato flour, glucose, sirup, mucilage, stock feed, and human food. Study briefly the minor uses mentioned above and the methods of making the products. Primarily, the chief attention should be given to the use of the potato as a human food.

3. The potato as a human food—(*a*) Food values, chiefly a starch food, but contains some protein and mineral matter.

(*b*) Advantages as a food—Furnishes an abundant supply of nutrients at a relatively low price; supplies nutrients in an easily digestible form; adds bulk to the food eaten.

(*c*) Textures of flesh in cooked potato—Soggy, usually rather low in starch and relatively high in protein; waxy, a greater proportion of starch to protein; mealy, starch content high, protein relatively low.

(*d*) Place in the general diet—Potatoes represent 3.9 per cent of the total cost of food, furnish 5.3 per cent of the total calories, 4.2 per cent of the total protein, 8.7 per cent of the total phosphorus, and 13.5 per cent of the total iron. Since phosphorus and iron compounds are as important to include in the dietary as protein and fuel foods, it is seen that for the small percentage of money expended for potatoes a generous supply of nutrients is obtained.

(*e*) Cooking—(1) Effects of cooking; transforms water into steam, expanding breaks down starch cells and free starch grains, coagulates the protein, affects minerals only slightly. Baking and steaming from all points of view are the best methods of cooking potatoes. (2) Losses in cooking; in paring, both by cutting away valuable material and exposing the soluble substances to the action of the water; in exposing a large amount of surface to the water; in soaking before cooking; in the use of cold water at the beginning of the cooking. (3) Recipes for using potatoes. Here a number of

well-tested methods for preparing potatoes for the table should be given and demonstrated.

Practical exercises.—In studying the composition of the potato, the pupils may make the tests themselves. (Caution: Be careful in handling the nitric acid.) Demonstrations in the methods of cooking potatoes may be made in the classroom. Recipes may be given out and the actual preparation may be done at home. If school lunches are served, the potato may form one of the foods served. Potatoes as a substitute for flour in various dishes may be demonstrated. The demonstrations at school should be followed up with the preparation of the same recipes at the home of the student.

Correlations.—Construct charts for the classroom showing the structure and the composition of the potato with relative amounts of each constituent.

Neat copies of recipes, reports on cooking processes, and a write-up of the study of the composition of the potato will give practice work in language, while a booklet on the uses of the potato well written, carefully prepared, and illustrated, if possible, will give correlation both in language and drawing.

Problems showing comparative cost of potatoes as a source of starch food with other starchy foods, and like comparisons as to supply of minerals, will afford practice work in arithmetic.

SUPPLEMENT.

Formula for Treatment of Seed Potatoes.

1. One pound 40 per cent formaldehyde to 30 gallons of water. Soak tubers for 2 hours. May be used over and over again for at least 10 times.

2. Four ounces dry corrosive sublimate to 30 gallons of water. Dissolve the powder first in a quart of warm water and then add it to the other. This solution should not come in contact with metal. Should not be used more than three times unless renewed. Soak potatoes for at least 1½ hours. Handle with great care, for this solution is very poisonous.

BORDEAUX MIXTURE.

Five pounds copper sulphate (blue vitriol).
Five pounds stone lime.
Fifty gallons of water.
Dissolve the copper sulphate in water.

Slake the lime with water. Then mix in a barrel containing 50 gallons of water. If desired, a 3.3:50 solution may be made, but the above is better. If used to any extent, slake solutions of both the copper sulphate and lime should be prepared and then added to the water when ready to use.

If desired to kill potato beetles or other insects, add to the Bordeaux mixture from 3 to 5 pounds of arsenate of lead or 1 pound of Paris green, and add 2 pounds of quicklime to prevent burning. One pound of Paris green to the acre either in water or Bordeaux mixture is ordinarily recommended. Arsenate of lead has the advantage of adhering to the vines and is only slightly washed off by the rains.

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